remark a fortnight ago, in noticing his newly published "Tables for Facilitating the Use of Sumner's Method at Sea," are of very high importance. The general adoption of Sumner's Method, now made simple for the navigator, would be a reform in navigation almost amounting to a revolution, and is one most highly to be desired. Sir William Thomson has also invented a new form of mariner's compass of exquisite construction. It possesses many advantages over the best of those in general use, not excluding the Standard Admiralty Compass; but its special feature is that it permits of the *practical* application of Sir George Airy's method of correcting compasses for the permanent and temporary magnetism of iron ships. He has also invented an apparatus for deep-sea sounding by pianoforte wire. This apparatus is so simple and easily managed that he has brought up "bottom" from a depth of nearly three nautical miles, sounding from his own yacht, without aid of steam or any of the ordinary requisites for such depths. His method was much employed in taking rapid soundings during the laying of telegraph cables along the Brazilian coast to the West Indies. It has also been used with great success on the United States Submarine Survey. Recently, while on his way to Philadelphia, Sir W. Thomson himself was able to take flying soundings, reaching the bottom in 68 fathoms, from a Cunard Line steamship going at full speed.

The treatise on "Natural Philosophy" written by Prof. Thomson, in conjunction with Prof. Tait, brings before us another branch of activity in which he has shown himself as eminent as in research.

Sir William Thomson is a Fellow of the Royal Society of London and of the Royal Society of Edinburgh. He has received the Royal Medal of the former and the Keith Medal of the latter. He is also an honorary member of several foreign societies. The Universities of Dublin, of Cambridge, and of Edinburgh have each conferred upon him the honorary degree of LL.D., and that of Oxford the honorary degree of D.C.L. On his marriage in 1852 he gave up his Fellowship at St. Peter's College, Cambridge; but in 1871 his college again elected him to a Fellowship, which he now holds.

Sir William Thomson's brother, Dr. James Thomson, is Professor of Civil Engineering in the University of Glasgow. He is well known as the discoverer of the lowering of the freezing-point of water by pressure; and is the author of many other important physical researches.

The following opinion of Sir William Thomson's merit as a worker in science has been sent us by Prof. Helmholtz:—"His peculiar merit, according to my own opinion, consists in his method of treating problems of mathematical physics. He has striven with great consistency to purify the mathematical theory from hypothetical assumptions which were not a pure expression of the facts. In this way he has done very much to destroy the old unnatural separation between experimental and mathematical physics, and to reduce the latter to a precise and pure expression of the laws of phenomena. He is an eminent mathematician, but the gift to translate real facts into mathematical equations, and *vice versâ*, is by far more rare than that to find the solution of a given mathematical problem, and in this direction Sir William Thomson is most eminent and original. His electrical instruments and methods of observation, by which he has rendered amongst other things electrostatical phenomena as precisely measureable as magnetic or galvanic forces, give the most striking illustration how much can be gained for practical purposes by a clear insight into theoretical questions; and the series of his papers on thermodynamics and the experimental confirmations of several most surprising theoretical conclusions deduced from Carnot's axiom, point in the same direction."

British science may be congratulated on the fact that in Sir William Thomson the most brilliant genius of the investigator is associated with the most lovable qualities of the man. His single-minded enthusiasm for the promotion of knowledge, his wealth of kindliness for younger men and fellow-workers, and his splendid modesty are among the qualities for which those who know him best admire him most.

METEOROLOGICAL RESEARCH

IN previous articles the necessity of dividing into two groups the subjects usually called meteorological has been strongly insisted on. The one of these may be termed climatic meteorology, and is intimately connected with physiology and those sciences which have reference to life. The other may be called physical meteorology, and recent researches have shown that this is intimately connected with other branches of physical inquiry, forming in its wider aspect a sort of meeting ground between molar and molecular physics—a region, in fact, where we find the largest bodies of the universe influencing the smallest.

It is a fortunate thing that we have no longer any need to enlarge upon the practical importance of the latter branch, since this is now recognised even by those who are furthest from considering science worthy of investigation for its own sake; while our present Government, who have shown themselves so willing to further the interests of abstract science, are, we believe, no less anxious to encourage amongst us a truly scientific meteorology. I think, therefore, that the present moment is an opportune one for discussing our subject from the point of view of pure science.

Nor is a feeling of national pride out of place even here. England is the greatest maritime nation on record, and her interests are represented in every quarter of the globe. If her offspring, America, is content to bestow a yearly subsidy of 50,000*l.* on meteorology, it is surely not too much to expect that the subject should receive the most liberal and enlightened treatment from the mother country.

One of the reasons why it is necessary to call attention to meteorology is because the science, being young, is in a very different position from that occupied by her sister sciences, chemistry and physics, so that we cannot be said to have a school of meteorologists at present existing. It would be an object of national importance to encourage the formation of such a school.

Again, while a want of clearness exists generally and everywhere regarding the scope of meteorology, there is also a large amount of widespread ignorance. When a leg of mutton dropped from Nadar's balloon into

the *place* of a French town, the Prefect thought it his duty to report the circumstance along with the state of the barometer and thermometer to his official superiors. Doubtless both dry and wet bulbs were accurately recorded. But I shrewdly suspect there are other nations besides the French who attach inordinate importance to the reading of dry and wet bulbs.

This confusion of mind arises doubtless from the state in which the science has been for more than a century—since the time when the *ignis fatuus* and the fall of an aërolite were grouped together as allied phenomena.

Leaving these times of extreme ignorance—the meteorologically dark ages—we next come to a period when our whole duty to meteorology was considered to be fulfilled by attaching observers of the barometer and thermometer to Royal Societies and Astronomical Institutions. These produced results, which were reduced after a mechanical and strictly statistical method, and then—put aside in a drawer. But we begin to perceive things more clearly now; we see that the duty we owe to the phenomena is to form them into a science, and that the last-mentioned method might have been pursued to the end of the world without leading to anything like a true science of meteorology. To take an extreme case, it would have been just as useful to tabulate the number of leaves that fall in autumn or the number of swallows observable in a day of summer. What then, it may be asked, are we to deal with? We reply that if we are to regard this subject as a science at all, we have here to deal with the action of external bodies upon the earth's envelopes, along with certain reactions of these envelopes upon each other. It will next be asked, How are we to deal with the subject?

In the first place, there ought, of course, to be a well-considered system of observations, which should be internationalised (if we may use the expression) as much as possible, so that each observation should be current coin over the largest possible area.

In the next place there must, of course, be a method of testing the accuracy of the observations. Lastly (and this is a point of the greatest possible importance), the individual observations ought to be thrown open to men of science in general, who should be encouraged and aided to utilise them to the greatest possible extent. Such continuous observations would thus lead to what may be called *sporadic researches*—that is to say, to researches not of the nature of ordinary reductions, and originating with men of science having free access to the observations and generously aided in their inquiries. It is only by this means that the edifice of a true science of meteorology can ever be erected, and then only stone by stone on the foundation of accurate observation.

Taking our present knowledge, let us see what sporadic researches naturally suggest themselves. For this purpose we may divide the subject into three parts—one embracing pure meteorology, another terrestrial magnetism, while a third has reference to the influence of the sun and moon upon terrestrial conditions.

In meteorology we should endeavour to obtain a clear and complete knowledge of the physical motions of the earth's atmosphere and liquid envelope, as well as of the various physical states of aqueous vapour existing in the air. Secondly, we should investigate the cyclical changes of these motions, and inquire into the causes of such changes. Thirdly, we should endeavour to utilise our knowledge, once obtained, in improving our power of predicting weather. In magnetism we should endeavour, by the help of observations already accumulated, to ascertain the causes of the changes which take place in the magnetism of the earth; and also to ascertain what is the nature of the connection between magnetism and meteorology. We should also investigate into the probable cause of the earth's magnetic polarity, and, lastly, ascertain whether a method of predicting meteorological changes may not be furnished by magnetism.

Thirdly and lastly, with respect to solar and lunar researches, we must ascertain the various periods and subperiods of sun-spot frequency, and of the frequency of solar faculæ and prominences.

We have then to investigate the causes and concomitants of these solar phenomena. It is well known that disturbances of the magnetism and meteorology of the earth are their concomitants. Well—we must try to find out whether such disturbances are caused by the solar outbreaks, or whether both are effects due to some common but unknown cause. Then, with regard to the moon, it will be necessary to investigate fully the nature of her action on meteorology and magnetism, and to ascertain whether this action is independent, or has reference to the position of the sun and to the state of his surface.

It ought here to be mentioned that the above list embraces only those prominent researches that have occurred to the writer of these remarks, and that if observations be thrown open and research encouraged, the dimensions of such a list would be almost indefinitely increased. And I will here repeat that it is only by carrying out such researches as those suggested that we can ever hope to raise meteorology to the rank of a true science.

It is well understood that the carrying out of such researches has formed no essential part of the duties discharged by the existing Meteorological Committee, and that as a matter of fact (with few exceptions) such researches have not been undertaken by them in the past.

Thus, whether or not the importance of such researches was in the minds of those statesmen who subsidised the present system, these inquiries have not yet been carried out, nor do we conceive that they could well be carried out by the existing machinery.

The Committee have, as a preliminary measure, directed their strength, perhaps wisely, to the accumulation of good observations, in other words, to laying the foundation of a future science, rather than to erecting the superstructure.

It remains to be considered whether any change in the present method of administration is absolutely necessary before research can receive due attention. We assume that the present meteorological system of the country is known to our readers: we may briefly state that this system is controlled by a committee consisting of eight unpaid members of the Royal Society, all of whom are eminent in science, although not all eminent in meteorology. This is sufficiently accounted for by reason of our statement, that there is not yet a true school or science of meteorology.

Through the past labours of these men and of their chief officers, the business of the meteorological office has now probably been put into a satisfactory position that will render unnecessary for the future any very great expenditure of energy upon the details of administration.

But such an arrangement, however excellent in a business point of view, must nevertheless necessarily fall short in developing scientific research. For this the undivided attention of several men of science must be secured, and the question we would here wish to submit to the consideration of our readers is the following.

Would not the combination of a few such men devoting their whole time to the subject, together with other men who though well acquainted with the subject, and otherwise qualified, are yet unable to devote their whole time to it, constitute the best possible committee of the future? We need hardly say that the functions of such a board would not be limited to that of producing research within itself. It ought likewise to stimulate and aid outsiders by various means, including advice and perhaps pecuniary aid. It might attach to itself as occasional members the meteorologists of the provinces, inviting their co-operation, giving and receiving advice, and it might even associate with itself as corresponding members, the meteorologists of the colonies and of foreign countries. In fine, the subject is one which perhaps more than any other demands the united action of men of various nations.

From what has just been said, it will readily appear that the sources of information upon which such a committee will draw in their investigations will by no means be confined to those which are under their own immediate control. The stores accumulated by foreign and colonial observers will, of course, be greatly drawn upon, and not only so, but the committee will doubtless also avail themselves of the stores of information possessed by other Governmental departments, as, for instance, those under the control of the hydrographer, who would naturally be a prominent member of the meteorological board, lending them his valuable assistance and co-operation. Besides the hydrographer, it would probably be found necessary to have, at least, three members of the board representing the three divisions of the subject already alluded to, who should be content to devote their whole time to their respective inquiries. The remainder would be composed of distinguished men interested in the subject, but unable to devote their whole time to it, embracing amongst them one or more mathematical physicists of high reputation.

If it be asserted that there are difficulties in the way of such an arrangement, it may be replied that undoubtedly there are; but if the subject were not one of difficulty, the Government would probably not have consulted the Royal Society from the very commencement of their inquiries. Such a powerful engine as a distinguished scientific committee, some of whom are pledged to devote their whole time, and others a portion of it, to the progress of scientific meteorology, is not meant to be used for the mere chopping of straws. The appropriate function of such a committee is surely that of overcoming difficulties.

BALFOUR STEWART

THE "ENCYCLOPÆDIA BRITANNICA."

Encyclopædia Britannica. Vol. IV. (Edinburgh: Adam and Charles Black.)

THE most prominent scientific contribution to the fourth volume of the "Encylopædia Britannica" is Prof. Balfour's article on Botany. In fact, with two other articles, it occupies a fourth of the whole number of pages, and this, together with its very comprehensive title, leads the reader to expect a tolerably complete review of all the various fields of botanical science, an expectation which is confirmed by their enumeration in the opening paragraphs. A little further examination shows, however, that it only treats of a single branch; the "Structure and Morphology of Plants;" "Classification" and "Distribution in Time and Space" are deferred for separate articles, and "Vegetable Physiology" has apparently dropped out of sight altogether. Any division of the matter is, for many reasons, better in an Encyclopædia than to despatch a whole subject *en bloc* with what is substantially a textbook rather than an article. But it is impossible not to regret that the vegetable side of Biology has not had a carefully planned series of contributions by different hands devoted to it like those which from the volumes already published appear to have been arranged for the animal side. And it is at any rate not easy to see why, as it is, one of several contributions should arrogate to itself the general title belonging to the whole. What would be thought of an article headed Zoology which only dealt with the myology of mammals?

The "Encyclopædia Britannica" has become, in its present edition, in a sense a national undertaking. It is so well supported by the best men in different departments of knowledge that it will no doubt come to be regarded as having a kind of representative character. The utterances of the several contributors will be taken as a kind of measure of the state of opinion in this country in each subject. From this point of view it is impossible not to feel that Prof. Balfour's exposition is disappointing as coming from so eminent a teacher, and that the idea it gives of botanical science is unsuggestive to the last degree.

Passing over an historical sketch of which many of the details, such as the last illness of the elder De Candolle, are essentially biographical, we commence with the "Structural Elements of Plants," in other words, their "General Histology." This opens with an account of the cell, which, even in its youngest condition, is stated to contain a sap-cavity; this is by no means the case, and the adjoining illustration, to which reference is made, shows cells with unvacuolated protoplasm, unless the nucleus is made to do duty for a vacuole. On the next page we are told that protoplasm "consists of albuminous substance mixed with water, and some incombustible materials," and that "it also contains some organic compounds;" are we to infer from this that albuminous substance is inorganic? From the cell we pass to the consideration of tissues, which are divided into cellular and vascular. This distinction carries us back half a century to De Candolle's "Organographie Végétale" (1827). Vegetable histologists have, indeed, laboured in vain from